Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 133 (2017) 16–27

Energy Procedia

www.elsevier.com/locate/procedia

Climamed 2017 – Mediterranean Conference of HVAC; Historical buildings retrofit in the Mediterranean area, 12-13 May 2017, Matera, Italy

Statistical analysis of the heating demand in residential buildings located in Mediterranean climate and proposals for refurbishment

Cristina Carpino[a,*], Roberto Bruno[a], Natale Arcuri[a]

[a]*Department of Mechanical, Energetic and Management Engineering (DIMEG), University of Calabria Via P. Bucci 46/c 87036 Rende (CS), ITALY*

Abstract

The paper deals with the investigation of the heating energy consumptions of a sample of residential buildings located in South Italy. A survey for the collection of data concerning energy performance certificates, characteristics of the building envelopes, air-conditioning plants and real consumptions, was carried out. A statistical analysis aimed at the identification of the main parameters affecting the energy requirements was developed using SPSS software. A multiple regression analysis was applied to obtain a forecasting tool that can be used to identify suitable action strategies for the retrofitting of buildings in the considered area.

Peer-review under responsibility of the scientific committee of the Climamed 2017 – Mediterranean Conference of HVAC; Historical buildings retrofit in the Mediterranean area

Keywords: Mediterranean climate, existing buildings, energy consumption, statistical analysis, prediction model, building refurbishment

1. Introduction

The building sector is liable to be one of the widest energy consumers. In accordance with the latest addresses of the European Union [1] all Member States should adopt the necessary measures to ensure high-energy performance of new and/or retrofitted buildings, with the aim of reaching a zero or positive energy balance.

* Corresponding author. Tel.: +39 0984 494614 Fax: +390984494673
E-mail address: cristina.carpino@unical.it

1876-6102
Peer-review under responsibility of the scientific committee of the Climamed 2017 – Mediterranean Conference of HVAC; Historical buildings retrofit in the Mediterranean area
10.1016/j.egypro.2017.09.365

The improvement of the energy performance of buildings accomplishes the dual purpose of reducing energy dependence on fossil fuels from other countries and of decreasing greenhouse gas emissions. In Italy, Ministerial Decree 26/06/2015[2], applying European directives, specifies the obligations to be met in constructions, with the goal of limiting energy consumption for the air conditioning. Consequently, all new edifices are built in compliance with the minimum requirements set by the Regulations. However, as a large part of the housing stock consists of existing buildings, the retrofitting of these structures to satisfy current energy efficiency and thermal comfort standards is firmly needed to concretely improve sustainability. An action spread throughout the territory is essential because, even if one single structure may not have any particular relevance, the system as a whole shows a network which constitutes the historic memory of the site [3]. Redeveloping the existing building stock represents an interesting opportunity to reach higher levels of environmental performance and reduce both energy consumption and CO_2 emissions required for its operation. As stated in Munarim and Ghisi [4], rehabilitation brings environmental and economic advantages. Also Martìnez-Molina et al. [5] confirmed the feasibility of preserving the built heritage while enhancing its energy efficiency and thermal comfort; furthermore, they claimed that Italy is leading the research in this field, thanks to the huge extent of its historical legacy. According to De Santoli [3] one of the fundamental processes of the energy upgrade of buildings is the energy audit. Several authors, e.g. Belpoliti and Bizzarri [6], Evola et al. [7], Droutsa et al. [8], propose the use of energy audits and data from energy performance certificates to briefly assess the energy consumption of entire building districts. In addition, building energy certificates should be used to produce an overview of the broad energy performance trends of buildings and drive improvements in energy performance by steering energy policy towards financial support of refurbishment strategies [9][10].

The estimate of building stock energy consumption is increasingly frequently carried out by extrapolating information from a wider database, created by assembling data collected through energy audits, but also by means of measurements, surveys, and simulations [11]. Forecasting models developed on the basis of large-scale investigations allow the prediction of the energy consumption of buildings, using few readily available parameters [12]. In Rhodes et al. [13] researchers performed a simulation model to predict the actual residential energy usage, with energy audits and surveys, under different scenarios of analysis. The combined IOA-LCA model proposed by Cellura et al. [14] aims to analyse the role of the building sector in the reduction of Italian energy consumption and CO_2 emissions. Koo and Hong [15]developed a dynamic energy performance curve for evaluating the historical trends in the energy performance of existing buildings. Recommendations on measures that can lead to a reduction in energy consumption are given in both Bojić et al. [16] and Ilić [17]; their recommendations essentially consist of different external insulation techniques, window replacement, installation of more efficient heating/cooling systems and application of renewable sources. The integration of several energy efficiency measures, if carefully planned, may even result in a Zero Energy Building after refurbishment, as shown by Corrado et al. [18] and Passer et al. [19] for residential buildings, and by Aksamija [20] for commercial buildings.

All the forecasting models are based on the strong interdependence between energy consumptions and some variables such as building shape, compactness, building age, surface area, etc. [21][22][12].

The association of the independent input variables with the dependent output variables is often performed by means of statistical analysis tools. Jang et al. [23] evaluated the characteristics in old apartment buildings that need to be considered for energy requalification. They found that, by using multiple regression analysis, three main features should be used as priorities for refurbishment schemes, namely the conditions of building envelope, the heating methods and the sizes of building units. Aranda et al. [24] and Chen et al. [25] used a regression analysis to develop analytic correlations for the prediction of energy consumptions in both the residential and the banking sectors. As asserted by Fan et al. [26], the drivers are many, varied, and complex, and involve local climate, household demographics, household behaviour, building stock and the type and number of appliances. Economical assessments conducted in several studies, e.g. Garrido-Soriano et al. [27], Ilić [17] and Pikas et al. [28], confirm that investment in energy efficiency is not only environmentally important but that it also provides economic benefits on an individual and government budget level.

This paper seeks to identify the characteristics of heating energy consumptions in a sample of residential buildings located in the region of Calabria, located in Southern Italy, typified by a Mediterranean climate. The investigation shows an overview of the energy performances of residential buildings in the interested area, obtained by the collection of energy certificates for the houses scattered throughout the territory. The study has allowed for the identification of the complex variables that can influence the energy consumptions for heating and DHW production in the considered